Coastal Engineering Technical Note

USE OF BITUMEN IN COASTAL STRUCTURES

PROGRAM: To call attention to the use of bituminous mixtures in coastal structures.

BACKGROUND: Bitumen or asphaltic bitumen is produced by refining crude petroleum oil. It is a durable cement with adhesive and waterproofing properties. It is also an elasto-plastic substance which imparts controllable flexibility to mixtures of mineral aggregate with which it is usually combined. Asphaltic bitumen is chemically inert; therefore, it is environmentally inoffensive.

TYPE OF BITUMINOUS MIXTURES: The three general categories of bituminous mixtures used in coastal structures are:

(1) Asphalt Concrete - This type of mixture is similar to asphalt concrete for roadway paving. The bitumen content is designed to be equal to the void volume of the fine and coarse aggregates to ensure an essentially voidless mix after compaction. Its mechanical properties are determined by both the bitumen and the mineral skeleton, while the permeability is governed by the efficiency of compaction. In most cases, the asphalt concrete for coastal works is applied on slopes such as the lining of dikes or revetments. Special attention has to be paid to the stability of the mixture as well as the stability of the subsoil or sublayer. Slopes steeper than 1:1.7 (vertical:horizontal) are not recommended.

A modified asphalt concrete, called stone asphalt, produced with a higher content of coarse aggregates, was developed for application to breakwaters in the open sea. The two-stage mixing procedure for this material, discussed by van Garderen and Mulbers (1983), requires special mixing equipment.

(2) Porous Asphalt Mixes - The bitumen content in this type of mixture is usually between 2 and 6 percent by weight and is less than the void volume of the aggregates. Because of the underfilled condition, the mixture is permeable; and its mechanical properties are governed by the aggregates. The bitumen acts only as a binder. An example is "lean sand asphalt" where the sand grains are stuck together by a thin film of bitumen. As a result, sand asphalt may be almost as permeable as natural sand and is commonly applied as a filter layer. Sand asphalt, when warm, behaves like loose sand. After cooling, it behaves like a soft sandstone when subjected to short-duration loadings.

Another example is "open stone asphalt" which contains approximately 80 percent (by weight) uniformly sized stone and 20 percent mastic asphalt. Two-stage mixing is also required for the production of this mixture (see van Garderen and Mulbers 1983). This open stone asphalt mixture can be used as an armor layer under light to moderate wave climate.

(3) Mastic Asphalts - These are mixtures of mineral aggregate and filler in which the voids in the mineral matrix are overfilled with bitumen. The result is an asphalt mix that can be applied by pouring or by hand-floating into place. A typical mastic contains 60 percent (by weight) sand, 20 percent filler, and 20 percent bitumen. The mechanical properties of the bitumen are dominant in determining mix behavior. At ambient temperature, mastic asphalt is highly viscous under long-duration loading. It behaves like an elastic material when subjected to short-duration loading, such as wave forces.

Mastic asphalt can be used in several ways including waterproofing, erosion and scour protection, and reinforcement or stability enhancement to rubble structures. Hot mastic mixes can be placed underwater through tremies, chutes, or by simply dumping in masses. For reinforcing, mastic asphalts are used as grouts to fill and plug the voids in stone structures such as jetties, breakwaters, and revetments (see Figure 1). The binding action of mastic asphalt tends to produce a more firm mass. This binding ability could possibly reduce the stone size required to produce a stable rubble structure but may increase wave runup and reflection. Also, such filling may increase maintenance costs due to undermining. Grouting techniques with asphalt mastics are discussed by Smith (1962) and Visser (1969).

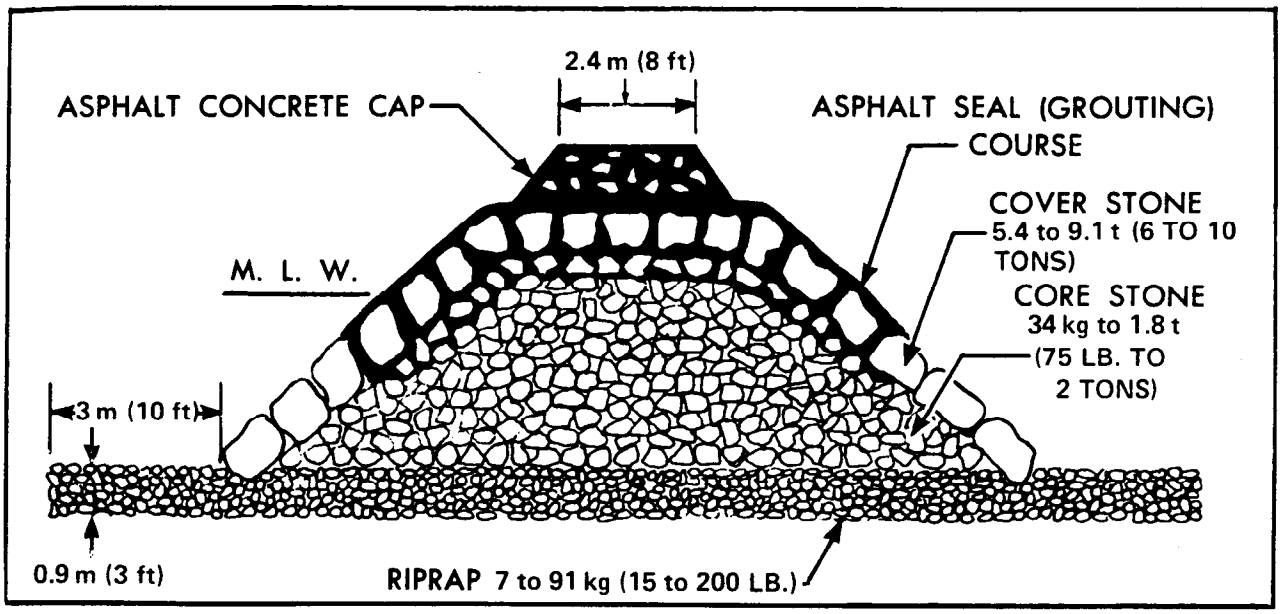

Figure 1 Cross section, south jetty, Galveston, Texas.

REFERENCES: Successful applications of bituminous mixtures for coastal structure are numerous, especially in Europe (see van Asbeck, 1959, 1964). Unfortunately, there is no proven criterion available at the present for design analysis. The following references provide additional information for design and application of bituminous mixtures in coastal structures.

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